In the Claims

Claims 91-93 are canceled.

Amend claims 63, 83 and 88 of remaining claims 32, 34, 36-42, 44, 46, 48, 49, 51, 53 and 55-90.

1.- 31 (Canceled)

32. (Allowed) A method of making a magnetic read head, which includes a spin valve sensor, comprising the steps of:

a making of the spin valve sensor comprising the steps of:

forming a free layer structure that has a magnetic moment and an easy axis;

forming a ferromagnetic pinned layer structure that has a magnetic moment;

forming a pinning layer exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

forming a nonmagnetic conductive spacer layer between the free layer structure and the pinned layer structure;

forming the free layer structure by obliquely ion beam sputtering at least one cobalt or cobalt based layer in the presence of a magnetic field oriented in a direction of said easy axis; and

the oblique ion beam sputtering being at angles $\alpha = 40°$ and $\beta = 10° - 30°$, wherein angles α and β form first and second planes respectively which are orthogonal with respect to one another.

33. (Canceled)

34. (Allowed) A method of making a magnetic read head, which includes a spin valve sensor, comprising the steps of:

a making of the spin valve sensor comprising the steps of:

forming a free layer structure that has a magnetic moment and an easy axis;

forming a ferromagnetic pinned layer structure that has a magnetic moment;

forming a pinning layer exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

forming a nonmagnetic conductive spacer layer between the free layer structure and the pinned layer structure;

forming the free layer structure by obliquely ion beam sputtering at least one cobalt or cobalt based layer in the presence of a magnetic field oriented in a direction of said easy axis;

the pinning layer structure being formed by forming a nickel oxide (NiO) layer and an alpha iron oxide (α FeO) layer wherein each of the nickel oxide (NiO) layer and the alpha iron oxide (α FeO) layer has been formed by oblique ion beam sputtering at angles α and β wherein angles α and β form first and second planes respectively which are orthogonal with respect to one another.

35. (Canceled)

36. (Allowed) A method as claimed in claim 32 further comprising the steps of:

forming the free layer structure with a nickel iron based layer that interfaces the cobalt or cobalt based layer; and

said forming of the cobalt or cobalt based layer so that it interfaces the spacer layer.

37. (Allowed) A method as claimed in claim 36 further comprising the step of:

after said oblique ion beam sputtering in the presence of said field oriented in said direction of the easy axis, further forming said at least one cobalt or cobalt based layer by annealing said at least one cobalt or cobalt based layer.

38. (Allowed) A method as claimed in claim 36 wherein said cobalt based layer is formed of cobalt iron (CoFe).

39. (Allowed) A method as claimed in claim 38 wherein said annealing is at a temperature from 150°C to 270°C.

40. (Allowed) A method of making a magnetic read head, which includes a spin valve sensor, comprising the steps of:

forming the spin valve sensor as follows:

forming a ferromagnetic pinned layer structure that has a magnetic moment;

forming a pinning layer exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

forming a nonmagnetic conductive spacer layer between the free layer structure and the pinned layer structure; and

forming the pinning layer structure of a nickel oxide (NiO) layer and an alpha iron oxide (αFeO) layer wherein at least one of the nickel oxide (NiO) layer and the alpha iron oxide (αFeO) layer has been obliquely ion beam sputtered at angles α and β wherein angles α and β form first and second planes respectively which are orthogonal with respect to one another.

41. (Allowed) A method of making a magnetic read head, which includes a spin valve sensor, comprising:

a making of the spin valve sensor including the steps of:

forming a free layer structure that has a magnetic moment and an easy axis;

forming a ferromagnetic pinned layer structure that has a magnetic moment;

forming a pinning layer exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

forming a nonmagnetic conductive spacer layer between the free layer structure and the pinned layer structure;

a making the free layer structure including the steps of:

obliquely ion beam sputtering first and second cobalt or cobalt based layers and a nickel iron based layer in the presence of a magnetic field oriented in a direction of said easy axis with the first and second cobalt or cobalt based layers interfacing the spacer layer and a cap layer respectively and the nickel iron based layer being located between and interfacing the first and second cobalt or cobalt based layers;

the oblique ion beam sputtering being at angles $\alpha = 40°$ and $\beta = 10° - 30°$ wherein angles α and β form first and second planes respectively which are orthogonal with respect to one another; and

after said oblique ion beam sputtering in the presence of said field oriented in said direction on the easy axis, annealing each of the cobalt or cobalt based layers and the nickel iron based layer.

42. (Allowed) A method as claimed in claim 41 including:

forming nonmagnetic nonconductive first and second read gap layers;

forming the spin valve sensor between the first and second read gap layers;

forming ferromagnetic first and second shield layers; and

forming the first and second read gap layers between the first and second shield layers.

43. (Canceled)

44. (Allowed) A method as claimed in claim 42 wherein a forming of the pinned layer structure comprises the steps of:

forming ferromagnetic first and second antiparallel (AP) pinned layers with the first AP layer interfacing the pinning layer; and

forming an antiparallel (AP) coupling layer between the first and second AP layers.

45. (Canceled)

46. (Allowed) A method as claimed in claim 44 wherein the step of oblique ion beam sputtering includes the steps of:

providing a sputtering chamber;

providing a nonmagnetic conductive target in the sputtering chamber that has a nominal planar surface;

positioning a substrate in the chamber that has a nominal planar surface at angles α and β to the nominal planar surface of the target;

providing an ion beam gun in the chamber for bombarding the target with ions which causes ions of the material to be sputtered from the target and deposited on the substrate to form said cobalt or cobalt based layers; and

angle $\alpha = 40°$ and angle $\beta = 10° - 30°$ wherein angles α and β form first and second planes respectively which are orthogonal with respect to one another and are angles between the nominal surface planes of the target and the substrate.

47. (Canceled)

48. (Allowed) A method of making magnetic head assembly that includes a write head and a read head, comprising the steps of:

a making of the write head including:

forming ferromagnetic first and second pole piece layers in pole tip, yoke and back gap regions wherein the yoke region is located between the pole tip and back gap regions;

forming a nonmagnetic nonconductive write gap layer between the first and second pole piece layers in the pole tip region;

forming an insulation stack with at least one coil layer embedded therein between the first and second pole piece layers in the yoke region; and

connecting the first and second pole piece layers at said back gap region; and

making the read head as follows:

forming a spin valve sensor and first and second nonmagnetic first and second read gap layers with the spin valve sensor located between the first and second read gap layers;

forming a ferromagnetic first shield layer; and

forming the first and second read gap layers between the first shield layer and the first pole piece layer; and

a making of the spin valve sensor comprising the steps of:

forming a free layer structure that has a magnetic moment and an easy axis;

forming a ferromagnetic pinned layer structure that has a magnetic moment;

forming a pinning layer exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

forming a nonmagnetic conductive spacer layer between the free layer structure and the pinned layer structure;

a making of the free layer structure including the step of:

obliquely ion beam sputtering first and second cobalt or cobalt based layers and a nickel iron based layer in the presence of a magnetic field oriented in a direction of said easy axis with the first and second cobalt or cobalt based layers interfacing the spacer layer structure and a gap layer respectively and the nickel iron based layer being located between and interfacing the first and second cobalt or cobalt based layers;

the oblique ion beam sputtering being at angles $\alpha = 40°$ and $\beta = 10° - 30°$ wherein angles α and β form first and second planes respectively which are orthogonal with respect to one another; and

after said oblique ion beam sputtering in the presence of said field oriented in said direction of the easy axis, annealing each of the cobalt or cobalt based layers and the nickel iron based layer.

49. (Allowed) A method as described in claim 48 including:

forming a ferromagnetic second shield layer;

forming a nonmagnetic isolation layer between the second shield layer and the first pole piece layer.

50. (Canceled)

51. (Allowed) A method as claimed in claim 48 wherein a forming of the pinned layer structure comprises the steps of:

forming ferromagnetic first and second antiparallel (AP) pinned layers with the first AP pinned layer interfacing the pinning layer; and

forming an antiparallel (AP) coupling layer located between the first and second AP layers.

52. (Canceled)

53. (Allowed) A method as claimed in claim 51 wherein the step of oblique ion beam sputtering includes the steps of:

providing a sputtering chamber;

providing a nonmagnetic conductive target in the sputtering chamber that has a nominal planar surface;

positioning a substrate in the chamber that has a nominal planar surface at an angle to the nominal planar surface of the target;

providing an ion beam gun in the chamber for bombarding the target with ions which causes ions of the material to be sputtered from the target and deposited on the substrate to form said cobalt or cobalt based layers.

54. (Canceled)

55. (Allowed) A method of making a magnetic layer and/or an antiferromagnetic (AFM) layer for an electrical device comprising the steps of:

obliquely ion beam sputtering at least one material layer from a target onto a substrate to form said magnetic layer and/or antiferromagnetic (AFM) layer;

the oblique ion beam sputtering being at angles α and β wherein each angle α and β is acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to each other.

56. (Allowed) A method of making a magnetic layer and/or an antiferromagnetic (AFM) layer for an electrical device comprising the steps of:

obliquely ion beam sputtering at least one material layer from a target onto a substrate to form said magnetic layer and/or antiferromagnetic (AFM) layer;

the oblique ion beam sputtering being at angles α and β wherein each angle α and β is acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to each other; and

the angle β being 10° to 30°.

57. (Allowed) A method of making a magnetic layer and/or an antiferromagnetic (AFM) layer for an electrical device comprising the steps of:

obliquely ion beam sputtering at least one material layer from a target onto a substrate to form said magnetic layer and/or antiferromagnetic (AFM) layer;

the oblique ion beam sputtering being at angles α and β wherein each angle α and β is acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to each other; and

the angle β being 20° and the angle α being 40°.

58. (Allowed) A method of making a magnetic layer and/or an antiferromagnetic (AFM) layer for an electrical device comprising the steps of:

obliquely ion beam sputtering at least one material layer from a target onto a substrate to form said magnetic layer and/or antiferromagnetic (AFM) layer;

the oblique ion beam sputtering being at angles α and β wherein each angle α and β is acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to each other; and

the angle β being 30° and the angle α being 40°.

59. (Allowed) A method as claimed in claim 55 wherein said at least one material layer is a nickel iron film and first and second cobalt based films with the nickel iron layer being located between the first and second cobalt based films for forming said magnetic layer.

60. (Allowed) A method of making a magnetic layer and/or an antiferromagnetic (AFM) layer for an electrical device comprising the steps of:

obliquely ion beam sputtering at least one material layer from a target onto a substrate to form said magnetic layer and/or antiferromagnetic (AFM) layer;

the oblique ion beam sputtering being at angles α and β wherein each angle α and β is acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to each other;

said at least one material layer being a nickel iron film and first and second cobalt based films with the nickel iron layer being located between the first and second cobalt based films for forming said magnetic layer; and

a second material layer comprising a nickel oxide film and an α phase iron oxide film that interface one another being obliquely ion beam sputtered at said angles α and β for forming said antiferromagnetic layer.

61. (Allowed) A method as claimed in claim 60 wherein for each of said magnetic and AFM layers the angle β is 10° to 30°.

62. (Allowed) A method as claimed in claim 61 wherein for said magnetic layer the angle β is 20° and the angle α is 40°.

63. (Currently Amended) A method as claimed in claim 55 wherein the electrical device is a magnetic head assembly and further comprises the steps of:

said at least one material layer being a ferromagnetic free layer;

a ferromagnetic pinned layer;

a nonmagnetic spacer layer located between the free and pinned layers; and

the pinned and spacer layers being ion beam sputtered at [[an]] only said angle α. ~~which is acute and at an angle β which is zero.~~

64. (Allowed) A method of making a magnetic layer and/or an antiferromagnetic (AFM) layer for an electrical device comprising the steps of:

obliquely ion beam sputtering at least one material layer from a target onto a substrate to form said magnetic layer and/or antiferromagnetic (AFM) layer;

the oblique ion beam sputtering being at angles α and β wherein each angle α and β is acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to each other;

said at least one material layer being a ferromagnetic free layer;

forming a ferromagnetic pinned layer;

forming a nonmagnetic spacer layer between the free and pinned layers; and

the pinned and spacer layers being ion beam sputtered at an angle α which is acute and at an angle β which is 10° to 30°.

65. (Allowed) A method as claimed in claim 64 wherein the free layer has a magnetic moment with an easy axis and the oblique sputtering of the free layer is done in the presence of a magnetic field oriented parallel to said easy axis.

66. (Allowed) A method as claimed in claim 65 wherein after oblique sputtering the free layer the free layer is annealed at a temperature from 150°C to 270°C in the presence of said field oriented parallel to said easy axis.

67. (Allowed) A method as claimed in claim 66 wherein for the free layer the angle β is 20° and the angle α is 40°.

68. (Allowed) A method as claimed in claim 67 wherein for the pinned and spacer layers angle α is 40°.

69. (Allowed) A method as claimed in claim 68 further including the steps of:

forming said antiferromagnetic (AFM) layer interfacing the pinned layer wherein the AFM layer includes a nickel oxide film and an α phase iron oxide film that interface one another; and

ion beam sputtering the nickel oxide film and the α phase iron oxide film at angles α and β wherein each angle α and β are acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to one another.

70. (Allowed) A method as claimed in claim 69 wherein for the AFM layer the angle α is 40° and angle β is 10° - 30°.

71. (Allowed) A method as claimed in claim 32 wherein the forming of the spacer layer includes oblique ion beam sputtering copper at angles $\alpha = 40°$ and $\beta = 10° - 30°$ with angles α and β being orthogonal.

72. (Allowed) A method as claimed in claim 41 wherein the forming of the spacer layer includes oblique ion beam sputtering copper at angles $\alpha = 40°$ and $\beta = 10° - 30°$ with angles α and β being orthogonal.

73. (Allowed) A method as claimed in claim 48 wherein the forming of the spacer layer includes oblique ion beam sputtering copper at angles $\alpha = 40°$ and $\beta = 10° - 30°$ with angles α and β being orthogonal.

74. (Allowed) A method of ion beam sputtering at least one layer comprising the steps of:

providing a substrate with a first planar surface;

providing at least one target with a second planar surface wherein the target is composed of a desired material for said layer;

positioning the planar surfaces at angles α and β with respect to one another wherein angle α forms a first plane intersecting the first and second planar surfaces and angle β forms a second plane intersecting the first and second planar surfaces as well as the first plane with the intersection of the first and second planes being orthogonal with respect to each other; and

ion beam sputtering the target so that said material is sputtered from the target onto said substrate to form said layer.

75. (Allowed) A method as claimed in claim 74 wherein a central ion beam lies within said first plane.

76. (Allowed) A method of ion beam sputtering at least one layer comprising the steps of:

providing a substrate with a first planar surface;

providing at least one target with a second planar surface wherein the target is composed of a desired material for said layer;

positioning the planar surfaces at angles α and β with respect to one another wherein angle α forms a first plane intersecting the first and second planar surfaces and angle β forms a second plane intersecting the first and second planar surfaces as well as the first plane with the intersection of the first and second planes being orthogonal with respect to each other; and

ion beam sputtering the target so that said material is sputtered from the target onto said substrate to form said layer;

a central ion beam lying within said first plane; and

the angle β being $10°$ to $30°$.

77. (Allowed) A method of ion beam sputtering at least one layer comprising the steps of:

providing a substrate with a first planar surface;

providing at least one target with a second planar surface wherein the target is composed of a desired material for said layer;

positioning the planar surfaces at angles α and β with respect to one another wherein angle α forms a first plane intersecting the first and second planar surfaces and angle β forms a second plane intersecting the first and second planar surfaces as well as the first plane with the intersection of the first and second planes being orthogonal with respect to each other; and

ion beam sputtering the target so that said material is sputtered from the target onto said substrate to form said layer;

a central ion beam lying within said first plane; and

the angle β being 20° and the angle α being 40°.

78. (Allowed) A method of ion beam sputtering at least one layer comprising the steps of:

providing a substrate with a first planar surface;

providing at least one target with a second planar surface wherein the target is composed of a desired material for said layer;

positioning the planar surfaces at angles α and β with respect to one another wherein angle α forms a first plane intersecting the first and second planar surfaces and angle β forms a second plane intersecting the first and second planar surfaces as well as the first plane with the intersection of the first and second planes being orthogonal with respect to each other; and

ion beam sputtering the target so that said material is sputtered from the target onto said substrate to form said layer;

a central ion beam lying within said first plane; and

the angle β being 30° and the angle α being 40°.

79. (Allowed) A method as claimed in claim 75 wherein said at least one layer is a nickel iron film and first and second cobalt based films with the nickel iron film being located between the first and second cobalt based films for forming said layer.

80. (Allowed) A method of ion beam sputtering at least one layer comprising the steps of:

providing a substrate with a first planar surface;

providing at least one target with a second planar surface wherein the target is composed of a desired material for said layer;

positioning the planar surfaces at angles α and β with respect to one another wherein angle α forms a first plane intersecting the first and second planar surfaces and angle β forms a second plane intersecting the first and second planar surfaces as well as the first plane with the intersection of the first and second planes being orthogonal with respect to each other; and

ion beam sputtering the target so that said material is sputtered from the target onto said substrate to form said layer;

a central ion beam lying within said first plane;

said at least one layer being a nickel iron film and first and second cobalt based films with the nickel iron film being located between the first and second cobalt based films for forming said layer; and

a second layer comprising a nickel oxide film and an α phase iron oxide film that interface one another being obliquely ion beam sputtered at said angles α and β for forming another layer.

81. (Allowed) A method as claimed in claim 80 wherein for each of said layer and said other layer the angle β is 10° to 30°.

82. (Allowed) A method as claimed in claim 81 wherein for said layer the angle β is 20° and the angle α is 40°.

83. (Currently Amended) A method as claimed in claim 75 wherein said method forms a magnetic head assembly further comprising:

said at least one layer being a ferromagnetic free layer;

forming a ferromagnetic pinned layer;

forming a nonmagnetic spacer layer between the free and pinned layers; and

the pinned and spacer layers being ion beam sputtered at [[an]] only said angle α. ~~which is acute and at an angle β which is zero.~~

84. (Original) A method as claimed in claim 83 wherein for the free layer the angle β is 10° to 30°.

85. (Original) A method as claimed in claim 84 wherein the free layer has a magnetic moment with an easy axis and the oblique sputtering of the free layer is done in the presence of a magnetic field oriented parallel to said easy axis.

86. (Original) A method as claimed in claim 85 wherein after oblique sputtering the free layer the free layer is annealed at a temperature from 150°C to 270°C in the presence of said field oriented parallel to said easy axis.

87. (Original) A method as claimed in claim 86 wherein for the free layer the angle β is 20° and the angle α is 40°.

88. (Currently Amended) A method as claimed in claim 87 wherein for the pinned and spacer layers angle α is 40°. ~~and angle β is 0°.~~

89. (Original) A method as claimed in claim 88 further comprising:

forming an antiferromagnetic (AFM) layer interfacing the pinned layer wherein the AFM layer includes a nickel oxide film and an α phase iron oxide film that interface one another; and

ion beam sputtering the nickel oxide film and the α phase iron oxide film at angles α and β wherein each angle α and β are acute and wherein the angles α and β form first and second planes respectively which are orthogonal with respect to one another.

90. (Original) A method as claimed in claim 89 wherein for the AFM layer the angle α is 40° and angle β is 10° - 30°.

91.- 93. Canceled